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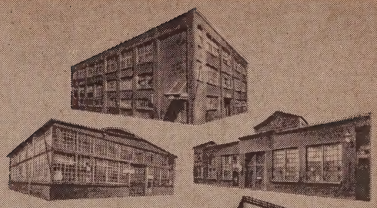

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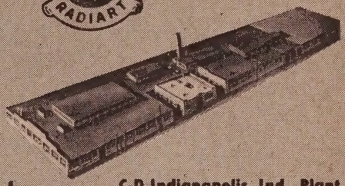

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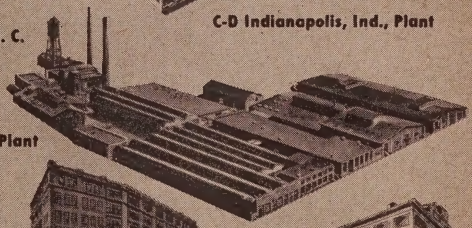

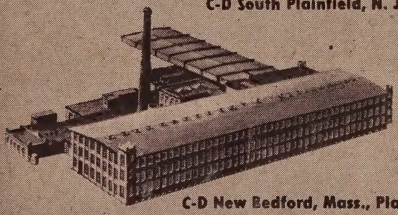

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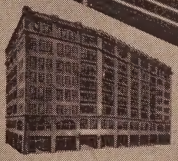

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MULTIVIBRATOR CIRCUITS and DATA

The multivibrator is a form of high-vacuum-tube relaxation oscillator. It has become well known to radio technicians as a submultiple frequency generator. In this connection, the multivibrator has been used widely as a frequency divider to obtain accurate low frequencies from a higher-frequency standard oscillator. The multivibrator has found new applications in television, radar, and modern electronic test instruments as a generator of pulses and other special waveforms.

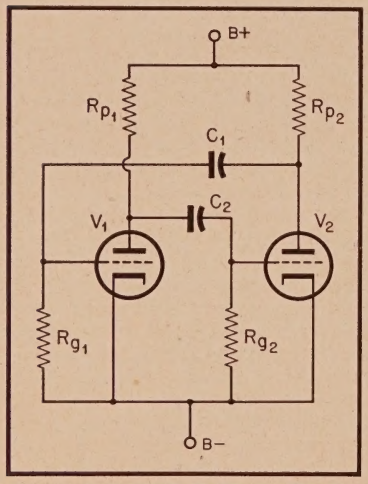

Fig. 1. Basic Multivibrator Circuit

The basic multivibrator circuit is shown in Figure 1. It is easy to see that this circuit would be that of a simple 2-stage resistance-capacitance-coupled amplifier if capacitor C_1 were removed. C_1 serves to connect the output (plate of tube V_2) back to the input (grid of tube V_1). It is this feedback path which enables the circuit to oscillate. For convenience and space economy, dual triodes often are employed in multivibrators.

Each tube in the circuit introduces a 180° phase shift which satisfies the conditions for oscillation. Thus, we may visualize a momentary positive potential at the grid of V_1. This potential causes the plate of V_1 to swing negative (less positive). The plate potential change at V_1 is transmitted by capacitor C_2 to the grid of tube V_2 which swings to a negative potential. The plate potential of tube V_2 accordingly becomes more positive, and this potential is transmitted by capacitor C_1 to the grid of tube V_1 where it arrives in the same phase as the original positive potential at that grid.

The natural frequency of oscillation of the multivibrator is dependent upon several factors, such as applied plate and bias voltages and circuit constants. The frequency of self-oscillation may be determined with sufficient closeness for most practical purposes from the values of grid resistance and coupling capacitance. Thus, in the circuit given in Figure 1:

$$(1)\quad f = \frac{1000}{(Rg_1\,C_1) + (Rg_2\,C_2)}$$

Where f is the frequency in kilocycles
Rg, the grid resistance in ohms
C, the coupling capacitance in microfarads

In symmetrical multivibrator circuits, Rg_1 is made equal to Rg_2, and C_1 equal to C_2. The equation then can be simplified to the following:

$$(2)\quad f = \frac{500}{RC}$$

Where f is the frequency in kilocycles
R, either grid resistance in ohms
C, either coupling capacitance in microfarads

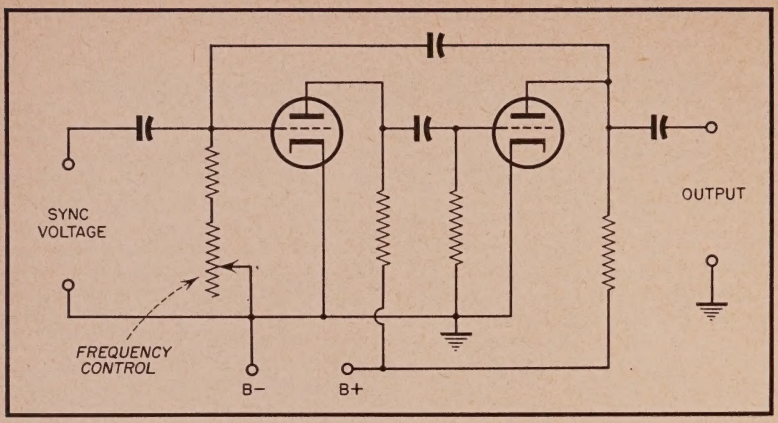

Fig. 2. Grid Signal-voltage injection.

Example. What is the approximate natural frequency of a multivibrator in which the grid resistors each are 10,000 ohms and each coupling capacitor is 0.005 microfarad? Here; R = 10,000 and C = 0.005. Hence, f = 500/(10,000 × 0.005) = 500/50 = 10 kc.

The plate resistors (Rp_1 and Rp_2) generally are made 5 to 10 times higher in value than the grid resistances. When the plate resistance is less than about 5 times the grid resistance, the plate resistance rather than the grid resistance appears to act in conjunction with the coupling capacitance to determine the oscillation frequency. In such cases, it can be observed that substitution of the plate resistance value for the term R in Equation (2) will yield the circuit frequency more closely than will the grid resistance. A practical rule of the thumb is to choose the plate resistance value ordinarily used with the selected tubes in a conventional resistance-coupled amplifier operated at the available B-supply voltage. The grid resistance value required for a given frequency then may be calculated by means of Equation (1) or (2). The natural frequency may be varied by adjusting one or both grid resistors.

Output of the multivibrator can be taken from either a grid or plate circuit. However, it is more customary to use the plate circuit of the second tube for this purpose.

A free-running multivibrator, like other relaxation oscillator circuits, is an unstable device. The frequency is capable of both fluctuation and drift, and the output waveform is irregular and rich in harmonics. The multivibrator is readily synchronized however, by means of a control voltage of suitable frequency which may be injected into the circuit. When synchronized in this fashion, the multivibrator will have the same frequency stability as that of the controlling source. The frequency of the synchronizing voltage may be a harmonic of the natural frequency of the multivibrator. It is this feature which enables the multivibrator to act as a frequency divider. Thus, a 10-kc. multivibrator may be synchronized by a control voltage derived from a 100-kc. oscillator.

The most positive locking action is obtained when the natural, uncon-

trolled frequency of the multivibrator is adjusted to slightly less than its controlled frequency. Adjustment over a narrow range may be obtained by making a portion of one of the grid resistors variable, as shown in Figure 2. A 10-kc. multivibrator may be adjusted initially to 9 kc. in the uncontrolled state. The injected synchronizing voltage will "draw" the multivibrator into control at a frequency equal to 1/n of the frequency of the synchronizing voltage. The sync voltage amplitude, as well as its frequency affects the controlled multivibrator frequency.

Sync voltage may be introduced into a grid or plate circuit. Figure 2 shows grid injection. Figures 3 and 4 show two variations of plate injection. While the controlled multivibrator frequency will be 1/n of the sync frequency, various methods of injecting the sync voltage favor even or odd values of n. If the multivibrator circuit is symmetrical (i.e., circuit constants in one stage of the circuit match those in the other stage); the grid injection method shown in Figure 2 will favor *odd* values of n, since the sync voltage is injected into only one half of the circuit. In contrast to this, the sync voltage is applied in Figure 4 to the plates of both tubes. This arrangement accordingly favors *even* values of n. Both odd and even submultiples are possible with the sync method illustrated in Figure 3. For better understanding, we might point out that an 11-kc. multivibrator may be more easily synchronized from a 100-kc. oscillator with the injection method given in Figure 2, since n in this case (11) is odd. The scheme in Figure 4 favors even values of n and thus would be more favorable for synchronizing a 10-kc. multivibrator from a 100-kc. source.

Behavior of the multivibrator under the influence of an injected sync voltage is characteristic of this type of circuit. If the multivibrator circuit constants are fixed and the sync voltage amplitude is increased in a smooth, unbroken variation, the multivibrator

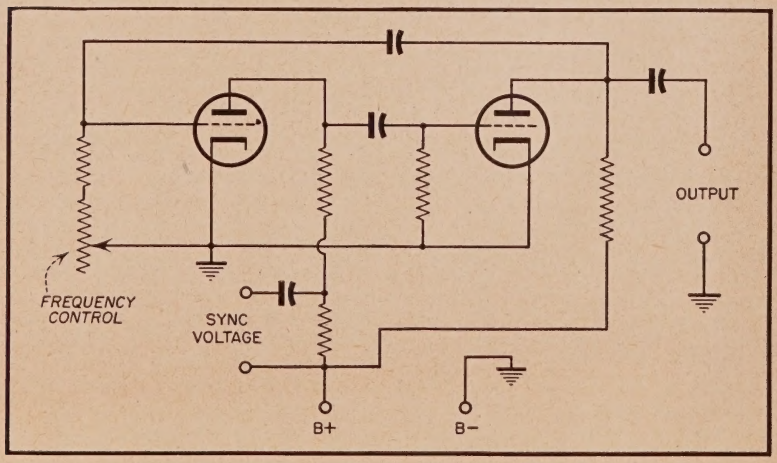

Fig. 3. Single-plate-signal injection method.

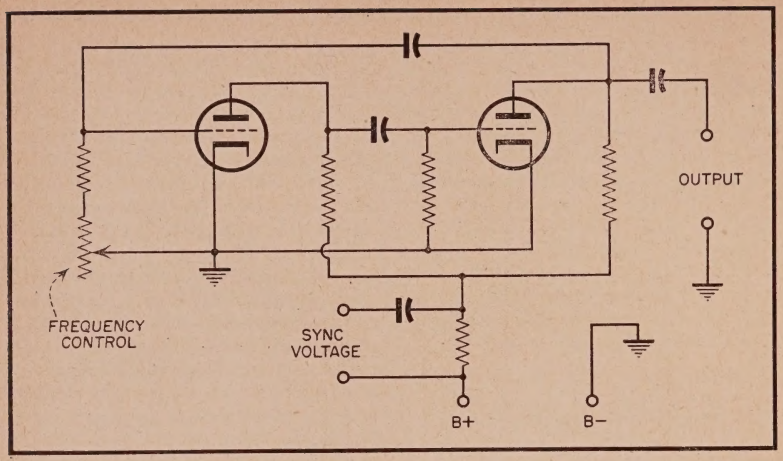

Fig. 4. Dual-plate-signal injection.

frequency will be observed to jump abruptly from one frequency to another in discrete steps as the amplitude increases. Thus, the frequency of a 1-kc. multivibrator will step from 800 to 900 to 1000 to 1100 cycles and so on, as the sync voltage amplitude is increased. If, on the other hand, the sync voltage amplitude is held steady at a suitable level while one of the multivibrator circuit constants (such as the 1st-stage grid resistor in Figures 2, 3, and 4) is varied, similar frequency steps will be obtained. When the multivibrator is locked-in closely with the sync voltage, small variations of the variable circuit constant will not cause the multivibrator to jump to the adjacent frequency step. The best sync voltage amplitude for positive control of the multivibrator is slightly higher than the value which just causes the multivibrator to jump to the desired frequency.

Figure 5 shows a variation of the standard multivibrator circuit. In this instance, the first plate is capacitance-coupled to the second grid. But the second tube is coupled back to the first by way of cathode coupling. Settings of both the variable common cathode resistor and variable grid resistor govern the natural oscillation frequency of the circuit.

Figure 6 shows another twin triode-type cathode-coupled multivibrator employed as the vertical oscillator in a television receiver. Sync pulses are injected into the grid circuit of the first tube. The variable grid resistor of the second tube, recognized as the frequency control already shown in previous circuits, functions as the **vertical hold** control of the receiver. The output of this multivibrator is a sawtooth wave. A similar circuit may be employed as the sawtooth sweep oscillator in an oscilloscope. An oscilloscope sweep circuit of this type is able to reach higher frequencies than are possible with common sawtooth oscillators employing gaseous tubes.

With slight variation, the conventional multivibrator circuit of Figure 1 may be used as a square wave generator. In this application, tube V_1 is biased negatively to cutoff, while tube

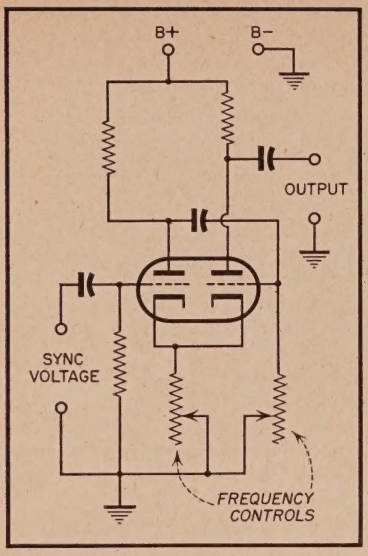

Fig. 5. Cathode-Coupled Multivibrator

V_2 has zero grid bias. A controlling sine-wave signal is presented, via capacitance coupling, to the grid of tube V_1. The output signal, which has the same frequency as the applied sine wave, is taken from the plate circuit of tube V_2 through capacitance coupling. The waveform of the output signal essentially is square.

Practical Considerations in Multivibrator Design

Circuit Symmetry. In a symmetrical multivibrator, care must be exercised to keep corresponding components as nearly equal in value as possible. Thus, the two plate resistors should be matched closely, as should also the two grid resistors and coupling capacitors. In exacting applications, such as frequency measuring instruments, multivibrator component values must be matched within at least 1 percent. Critical applications often require use of precision wirewound instrument-type resistors in both grid and plate circuits.

Tube Considerations. It is good practice to match the tubes to be used in a multivibrator, although this requirement for matching is not nearly as critical as that for resistors and capacitors. In most cases, it will be sufficient to select tubes having the same transconductance. However, some exacting applications, such as use of a multivibrator at a high frequency, may make it advisable to select tubes with matching interelectrode capacitances as well.

In conventional applications, multivibrators are not required to deliver power. Hence, small voltage amplifier triodes are entirely satisfactory for this use. Dual triodes are especially desirable for multivibrator use, since these tubes conserve space. These tubes include Types 6C8-G*, 6F8-G*, 6J6, 6SC7, 6SL7-GT*, 6SN7-GT*, 7F7*, 7F8*, 7N7*, 12AH7-GT*, 12AT7*, 12AU7*, 12AX7*, 12SC7, 12SL7-GT*, 14F7*, and 14N7*. In many multivibrator circuits, each triode must be biased separately. Dual triodes for these applications must have separate cathodes if separate bias voltage supply units are to be avoided. In the foregoing list, those tube numbers which are followed with an asterisk (*) indicate separate cathode types. For critical applications requiring exceptional tube matching and long-term stability, special "red tubes" 5691 (equivalent to 6SL7) and 5692 (equivalent to 6SN7) are available.

Power Supply. For maximum stability, especially when sync voltage amplitude is borderline as regards "holding", the multivibrator plate voltage should be held constant by means of a voltage regulator. VR-type gase-

ous voltage regulator tubes are satisfactory for this purpose.

Circuit Layout. Design rules pertaining to resistance-capacitance-coupled amplifiers are applied to design and construction of multivibrators. Usually, the maximum frequency at which a comparable RC-coupled amplifier may be operated will be very nearly the maximum efficient operating frequency of the multivibrator. When high-order harmonics of the multivibrator are of interest, every precaution must be taken to minimize stray capacitances throughout the circuit, since these capacitances attenuate the higher harmonics.

Isolation. Single-stage aperiodic RC-coupled amplifiers before and after a multivibrator will serve as buffers to isolate the latter from the sync voltage source and from the load. In some applications, this isolation is not necessary. But it is a requirement in frequency standards where interaction between stages can introduce instability and cause spurious oscillations. Occasionally, the isolating amplifiers are provided with suitable peaking coils for wideband operation.

Sync Frequency. Multivibrators have been synchronized experimentally by means of control voltages having frequencies between 20 and 50 times the natural frequency of the multivibrator. However, best locking action and stability are obtained when the control frequency does not differ from the multivibrator frequency by more than a factor of 10. Locking is quite positive when the multivibrator and sync voltage frequencies have the same value.

Adjustable Component. For purposes of synchronization and frequency control, one grid resistor in the multivibrator often is made variable. In order to obtain smooth operation, a fixed and variable resistor are connected in series. The resistance of the variable unit should not be greater than one-half the total grid resistance.

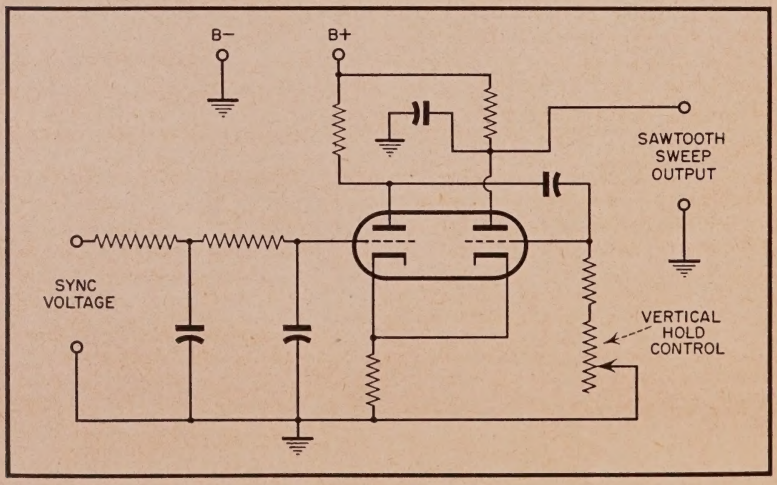

Fig. 6. Vertical (sawtooth) T.V. oscillator.

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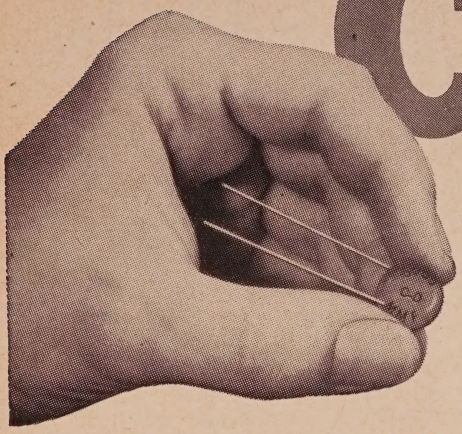

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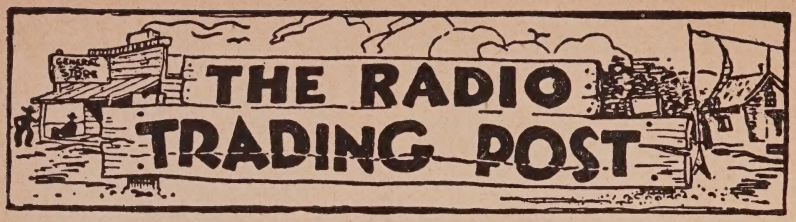

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FOR SALE—N.R.I. electronic radio tester, tube and batteries. Never used over ten times. Price $12. Many transmitting parts. State needs. T. B. Winstead, P. O. Box 113, Elm City, N. C.

TRADE—Complete set 10 vols. Winston Business Administration library. Cost $60. Perfect condition. Make offer of radio equip., or what have you? Owen's Radio Service, Box 5, Fayetteville, N. C.

FOR SALE—Hallicrafter 7" TV with magnifier, perfect. Want cash, slide projector, enlarger, 35mm camera. R. Crandall, 108 Pidgeon Hill Rd., Huntington Sta., N. Y.

WANTED—Rider Chanalyst or Meissner Analyst and audio oscillator. State price and condition. Also have items to trade. Please state wants. Bernard Fritz, 434 Carsonia Avenue, Pennside, Reading, Pa.

SELL OR TRADE—CRT, 5", never used. VT111; what have you? Best offer takes. A. J. Catalano, 713 William, Omaha 8, Nebr.

WANTED—A custom 12½" magnifier for a Templeton TV, model H1776. Ray Jankowski, 5801 Elgin St., Pittsburgh 6, Pa.

FOR SALE—Nicely converted BC-348 N receiver, $75 f.o.b. Precision E200-C sig. gen. like new, $50. Bryce H. Cox, General Delivery, Winston-Salem, N. C.

FOR SALE—Almost new, Polic-Alarm FM receiver, covering 152-163 mc., with antenna, $38 f.o.b. Atlanta. Walker R. Jones, 1094 E. Confederate Ave. S.E., Atlanta, Ga.

WANTED TO BUY—Freed-Eisemann "Educator" model 155C FM-AM radio. Must be reasonably priced. State price and condition. Walter J. Bartell, 1458 N. Ashland Ave., Chicago 22, Illinois.

WANTED—Late model conductance tube checker in good working condition, portable preferred. Will trade 20 watt Clark Audio amplifier, perfect cond. Also have tubes, send for list. S. J. Consalvo, 2507 Southern Ave. S.E., Washington 20, D. C.

TRADE—Have Philco 7050 tube tester, Heath scope, Weston Master II exposure meter. Want tape recorder, small TV or what? L. Putnam, Woodward, Iowa.

FOR SALE—National NC-240 short wave receiver. Also tape recorder and Stromberg-Carlson TV set. Reasonable. H. Latko, 1922 Dickens, Chicago.

WANTED—Electrical books on house wiring, construction wiring, conduit, etc. Will buy or trade. B. H. Buchanan, Hawk, N. C.

SALE OR TRADE—BC-659 transmitter and receiver with PE-120 Power supply 6-12 or 24 volt d.c. B. R. Wilson, 1535 Harrison St., Memphis 8, Tenn.

FOR SALE—Eico sweep generator model 360, used slightly, has a 5 kc. marker crystal. Make an offer. Edward Talisse, 656 10th St., Brooklyn 15, N. Y.

SELL OR SWAP—Have auto vibrators that can be repaired by those interested in same. Make offer? Selcraft, 394 Spring Valley, N. Y.

TRADE OR SELL—ARB receiver with dial crank and cable, 195 to 9050 kc. Also May, 1948, to April, 1950, Proc. of the I.R.E. Want good FM tuner, VOM, or camera. John Gleason, P.O. Box 132, Lake Wales, Florida.

WANTED—Auto radio for 1950 Chrysler New Yorker. Trade test equip., parts, tubes, or surplus radio units. H. F. Bernard, 3670 S.W. 9th Ter., Miami, Fla.

FOR SALE—Rider Manuals, new cond., never used. Vols. 5, 7, 8, 9, 10, 11, 12, 13, 14, $15 each, f.o.b. None sold singly. John Ransome, 207 So. Edison Ave., Tampa, Florida.

WANTED—BC779, S-72, or Command type broadcast receiver. Cash. George S. Maxey, 2154 Court St., Redding, Calif.

TRADE—RCA model TC247 12½" TV console set for a good tape recorder. Walter Kryger, 4918 Beech St., Hammond, Indiana.

FOR SALE—Supreme 542 multimeter in metal case with protective metal cover for meter. D.C. to 1500V a.c. to 600V, 2 megohms in 5 ranges. Best offer. Louis Failkoff, 143-48 41 Ave., Flushing 55, N. Y.

SELL OR SWAP—Supreme 85-PL tube tester; Franklin 33-H tube tester; Safeguard Checkwriter. Want late type tubes. I. W. Stubblebine, 140 S. 4th St., Reading, Pa.

SWAP—Lionel electric train, complete with transformer, 1 set switch tracks, tracks, cars, water tower, beacon light, plastic phone poles, 24 plastic houses, for a late model tube tester in 1st class cond. R. W. Landry, 2600 Pauger St., New Orleans 16, La.

WANTED—HRO with ham coils. For sale, 46 Colt with super holster, both excellent cond. E. Hanlon, 1551 Washington St., E. Charleston, W. Va.

FOR SALE—Transvision deluxe model 15" TV set, four stage Dumont inputuner, perfect working order, no cabinet. Best offer over $100. Roger Kolb, 550 Adams St., Red Hill, Pa.

SWAP—Rider vols. 1 and 2 for vol. 4, 5, or later than vol. 8. H. A. Nickerson, 435 N. Main St., Sharon, Mass.

FOR SALE—G.I. dual speed recorder and play back. Magnetic cutting head. Used only few times, $22. Earl W. Horne, Jennings, La.

TRADE—1230 Superior sig. gen. and NRI tester. Want electric drill or what have you? Billy Jones, RFD 2, Louisville, Tennessee.

FOR SALE OR TRADE—Jackson model 641 signal generator, $95 cash, or trade for 12, 16, or 20 ga. pump or auto loading shotgun. Jim Sylvester, 3370 "C" St., Niagara Falls, N. Y.

TRADE—Have Speco signal tracer, Eico 5" oscilloscope, Eico VTVM, 2 Rider Manuals. Need 8mm projector and equip. What do you have? Ben Steiner, 115 S. 8th St., Brooklyn 11, N. Y.

FOR SALE—Jim Lansing 208 speaker, $20; University 6200 speaker, $15 postpaid. Want Altec 604 or 604B. C. B. Parkinson, 431 Encinitas Monrovia, Calif.

WANTED—Operators Manual for Supreme 385 automatic tube and set tester. State price. Dominic Bianchi, 338 Harris St., Kent, Ohio.

FOR SALE—Hickok model 203 VTVM, unused; Garrard model 201B/3 transcription turntable. Make cash offer. Michael Landis, 29 West 12th St., New York 11, N. Y.

FOR SALE—Motorola Airboy Sr., receives 200-400 kc., transmits 3105 kc., complete, uses dry batteries, $25. Bell and Howell 16mm diagonal film splicer, perfect, $3 Hal Magargle, 790 Garrett, Upper Darby, Pa.

FOR SALE—Heath tube tester, $20; Hickok VOM meter model 4955S, $8; RCA station allocator model 171, $7. Albert Beilfuss, 8532 School St., Morton Grove, Illinois.

FOR SALE—Latest Gonset 2 meter conv., $37.50; National model NC 7M or 7W TV test set with videometer, 7" screen in grey metal carrying case with handles. First $69.50 takes it. f.o.b. N. K. Stover, 1357 Hill St., York, Pa.

FOR SALE—Excellent Pilot FM tuner, and one 30 watt amplifier with mic., phono, and 16mm projector input, both for $40, or tuner $10, amp., $30, or swap for what have you in photo supplies. Bert Chahye, R.D. 2, Eyria Ave., Lorrain, Ohio.

SELL—Weston Socket Selector model 666, $5; Navy RBZ pocket super-het, $28; Back issues Radio, QST, R9. Want Millen grid dipper. H. McEntee, 490 Fairfield, Ridgewood, N. J.

SWAP—Beautiful Colt .45 with holster. Want RCA WV-77A, or WV-97A type VTVM, or Simpson 303 VTVM. Perfect Simpson 260 with carrying case acceptable. Please state cond. Robert L. Ingram, 140 N. Harrison St., Easton, Md.

FOR SALE—Many used radios of standard make such as: Kolster, Philco, Majestic, Espey, G. E., etc. Enclose stamped envelope for list. Louis A. Goldstone, 1274 Sheridan Ave, Bronx 56, N. Y.

FOR SALE—Precision 912 tube checker; Webster 78-1 wire recorder; McGrade M-100 intercomm. w/sub station; Philco universal car radio; back issues Radio Electronics mag., from 1945. Need Sams Photofact, or what have you? George Stout, 1010 Chestnut, Kansas City 1, Mo.

WANTED—Solar capacitor analyzer model CF Solar Exam-eter, type 1.60, 115V 50-60 cycles. Or just the power transformer in good cond. Al. Noble, 1502 Fifth Ave., Pittsburgh 19, Pa.

SWAP OR SELL—Hickok 288X; Hammarlund HQ-129X; Precision 915-954 checkers. Need VTVM; 5" scope; sweep gen; 508 Motorola car radio. John Pellock, 614 W. North, Decatur, Ill.

SELL OR SWAP—Test-rite sig. gen., 150 kc. to 50 mc., battery operated, $12; Mallory battery booster, 2-4 amps, $7. What have you? Jack Traxlers, 412 Adams St. S. E., Grand Rapids 7, Mich.

WANTED—Rider Manuals vols. 12, 10, 9, and 8. J. Bartlett, 261 Whitman St., New Bedford, Mass.

SELL OR SWAP—Rider Manuals vols. 8 to 16 incl.; Rider Record Changer Manual. All in excellent condition. C. Wendling, 18889 Cardoni, Detroit 3, Mich.

SALE OR TRADE—Speed Graphic 2¼ x 3¼ all accessories, super Omega enlarger 4 x 5, misc. equip; for TV test equip., used TV, or what have you? C. E. Shephard, Mt., Vernon Rd., R.D. 2, Somerville, N. J.

FOR SALE—Hallicrafter S-29 portable, fair, $35. Webster wire recorder, model 80, $65. Abbott TR-4 transceiver 2 meters, excellent, $15. Trade for Currier and Ives prints or marked American pewter. Phil Dunne, Mill Rd., Stamford, Conn.

WANTED—Small RCA or Columbia record player to plug into RCA radio, also records. Have cash, watches, etc. A. E. Levriett, Box 3542 Sta. F, Jacksonville, Fla.

WANTED—Some No. 15 - 2 volt radio tubes. E. Kiehnhoff, Box 355, Wathena, Kansas.

WANTED—Rider Manuals. Entire set or separate volumes. Write giving cond. and lowest cash price. A. Adams, 719 Park Ave., Williamsport, Pa.

SALE OR EXCHANGE—Used high fidelity audio equip. in perfect cond. sold on a money-back guarantee. Write for list or offer amplifiers, tuners, speakers, recorders, three-speed changers. W. Colbert, 159-19 Hillside Ave., Jamaica 2, N. Y.

SALE OR TRADE—Millen R9er complete with 6AK5 tube and 28 meg. coil, also Fada table cabinet for 10" RCA 630 chassis. Perfect cond. J. Goldfarb, 3521 Cedarbrook Rd., University Heights 18, Ohio.

WANTED—Mobile transmitter, receiver, and equipment for 2 or 10 meters. George Dunseath, 2131 Clinton Ave., Bronx, N. Y.

WANTED—Sam's vol. 3 to date. Cash for cheapest set offered. Also want late radio-TV course. Send details. H. W. Smith, 503 Walsh St., Austin 3, Texas.

FOR SALE—Brush Development "Mail-A-Voice" magnetic recorder with 18 new record blanks. In very good condition. Paul B. Farrar, Norwich, Kansas.

FOR SALE—Sams Photofacts from 1 to 82 inclusive. All in perfect cond. $100 cash. Ralph Savage, 2302 Cadie Ave., Dayton 4, Ohio.

FOR SALE—Rider Manuals vols. 1 to 5, 9, 10, 11, 12, 13, and 14, all clean; Sylvania tube checker, used 6 mos., cost $114.50; Keystone 16mm silent projector. Make offer. G. M. Yates, 639 West Gains St., Tallahassee, Florida.

SWAP—Stancor ST203A and dynamotor PE103A, master mobile antenna, crystals, meters, tubes, misc. parts. Want reflex type camera, size 120 or 620 in good shape. May pay some cash difference. E. E. Hoover, P. O. Box 1025, Newark, Calif.

FOR SALE OR SWAP—Howard Sam's Photofacts, vols. 1 thru 10. Will accept tape or wire recorder, 3-speed record changer, etc. Make offer. Cpl. Richard Allen 14384203, 3320 Tng. Sqdn., Box 250, Scott A.F.B., Illinois.

FOR SALE—5 - 2-tube wireless phono oscillators, using one 6A8 and one 6J5 tubes. $5 for all without tubes, $8 with tubes. Robert Fischer, 835 West 176th St., New York 33, N. Y.

WANTED—A position with an experienced audio engineer in North Idaho or Spokane, Wash. I have completed a course in audio engineering at the Hollywood Sound Inst. Pay is secondary. Paul W. Conner, Box 37, Viola, Idaho.

SELL—Excess tubes, transformers, oil filter condensers, chokes, milliameters, crystals, etc. M. Lewis, 1523 - 41 St., Brooklyn, N. Y.

FOR SALE—"Cal 88" Dual Heat soldering gun, very good. Also a large supply of surplus parts, sell by pound or trade for anything you may have. Harry Spahr, 126 Hamilton Ave., York, Pa.

FOR SALE—Hickok 288X sig. gen., perfect, in original carton with instruction book, $125. Want pair Zeiss 8 x 60 binoculars. M. E. Gaines, P. O. Box 125, Ft. Madison, Iowa.

WANTED—Weston 301 milimeter 0-1, also panel 3" voltmeters. Varied assortment. Ira I. Walker, 1612 Cent Ave., Great Falls, Mont.

SALE OR TRADE—Triplett model 3432 sig. gen., cash or good 35mm camera. Also have transmitter and receiver of 274-N Series for best cash offer. Cpl. Dale Raper, T250011 2nd St., Jester Park, Fort Bliss, Texas.

FOR SALE—Model 772 Weston Analyzer; Model 636 Jackson Dynamic tubetester; Model T03 Sprague Tele O Mike resistor condenser analyzer. Geo. Martin, P.O. Box 671, Plattsburg, N. Y.

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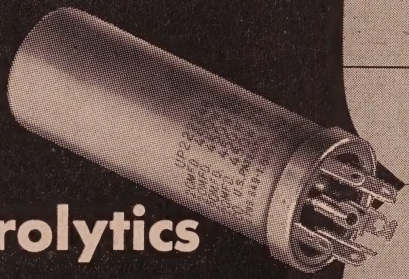

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